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Banter Gebang LFG (Landfill Gas) Collection & Energy Recovery CDM (Clean Development Mechanism) Project

PREPARED BY

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CLEAN DEVELOPMENT MECHANISM
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CONTENTS

Annexes

SECTION A. General description of project activity

A.1 Title of the project activity:

BANTAR GEBANG LFG COLLECTION & ENERGY RECOVERY CDM PROJECT

A.2. Description of the project activity:

The Bantar Gebang landfill site belongs to the government of DKI Jakarta, but is located in city of Bekasi, approximately 40km north of downtown Jakarta. The total area of landfill site is 108ha (effective area: 68.46ha) and is divided into 5 zones. The landfill site has been operated since 1989 and receives approximately 6,000 tons per day of domestic and non-hazardous industrial waste. DKI Jakarta operates the landfill including collection and transportation of municipal solid waste. Daily operation of the landfill site is committed to the private company funded both by DKI Jakarta and Bekasi City. The landfill site is almost full, and planned to be terminated in a few years. However, since there are no other capable landfill sites receiving DKI's wastes nearby, the Bantar Gebang landfill site will have to continue its operation.

The project involves installing equipment for landfill gas collection for fuel and energy recovery with gas engine generators. The plant will consist of gas collection pipeline system, a gas dryer, a gas holder, and gas engine generators.

By moving its gas recovery zones within whole Bantar Gebang landfill site, the project activities will be carried out continuously. Therefore, the operational lifetime of the project activity might be modified according to the landfill operation hereafter. In this document, we evaluate the project feasibility focusing on Zone IV and V for ten years.

The recovery volume of landfill gas in 2008, the first year of the proposed project, is estimated to be approximately 56,000 Nm^3/day for Zone IV and V.

The project is intended to play an important role in the safety closure of the landfill site by eliminating the emission of landfill gas. The project is consistent with the national criteria and indicators of sustainable development, which is mentioned in a draft of "the Indonesian DNA's Approval Mechanism", policy paper of the Ministry of Environment.

Contributions of the project to the Greenhouse gas (GHG) effect are as follows.

- Destruction of methane by collecting landfill gas formed inside the accumulated waste in the landfill site, and
- Reduction of carbon dioxide by emission replacing electricity from fossil fuel consumption to renewable energy.

A.3. Project participants:

Special Purpose Company (SPC) in Indonesia will be established for this particular project. The member of the SPC will be Kajima Corporation, some Japanese companies eligible to participate in this project such as electric companies, and some Indonesian companies such as IPP companies and/or waste management companies.

More detailed survey regarding project economic feasibility and further discussion and negotiation with local participants will be required to invite private funding.

For general questions or comments related to any aspect of this project, please contact

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A.4. Technical description of the project activity:

A.4.1. Location of the project activity:

The site is located at latitude 06° 15′ north and longitude 106° 30′ east, and about approximately 40km north of downtown Jakarta. The location map is shown in the following.

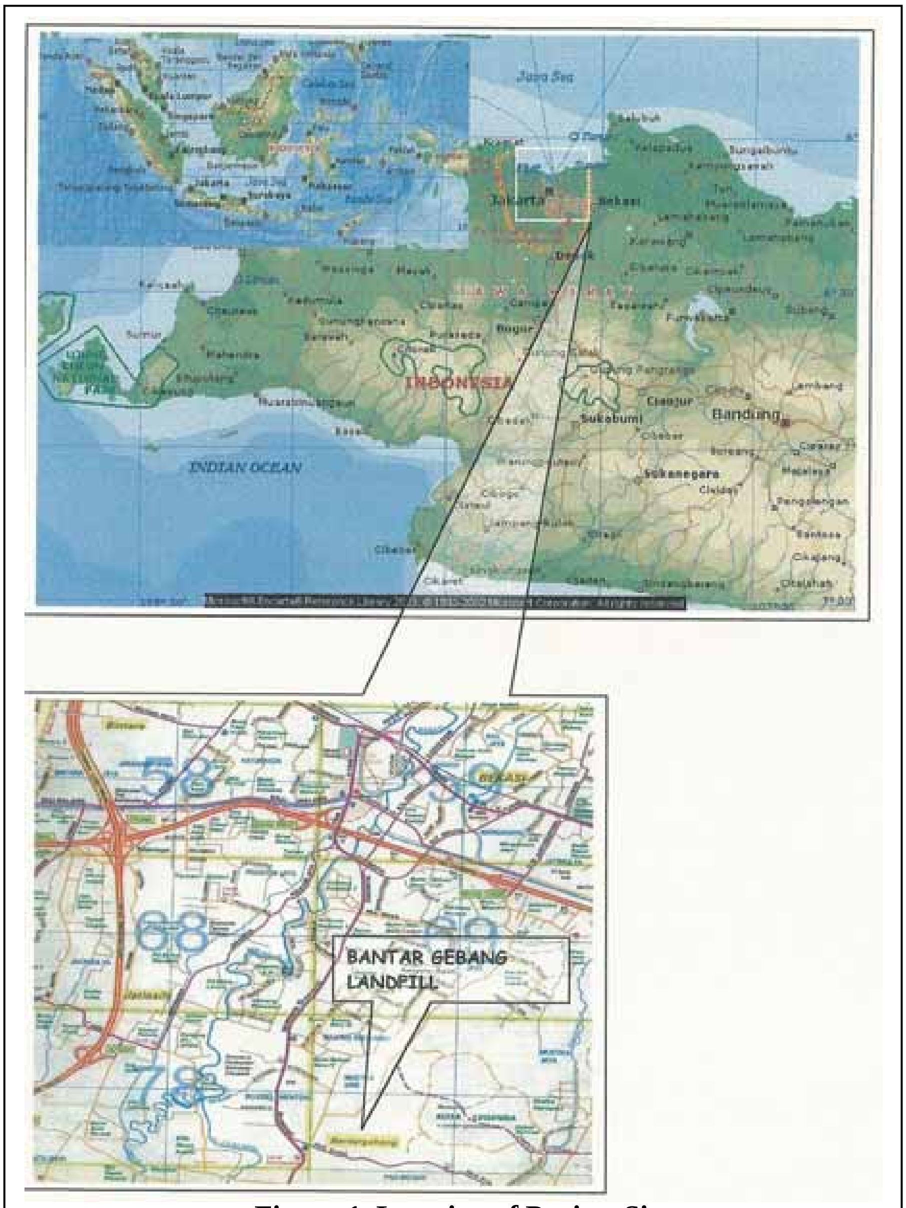


Figure-1 Location of Project Site

A.4.1.1. Host Party(ies):

Indonesia

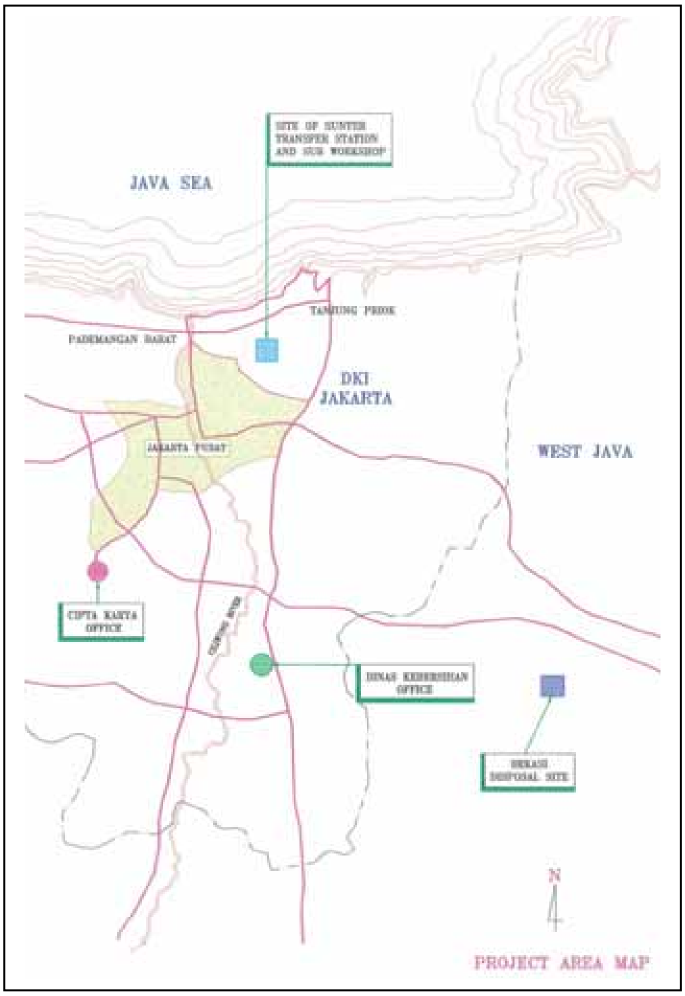
A.4.1.2. Region/State/Province etc.:

West Java

A.4.1.3. City/Town/Community etc:

City of Bekasi

A.4.1.4. Detail of physical location, including information allowing the unique identification of this project activity (maximum one page):



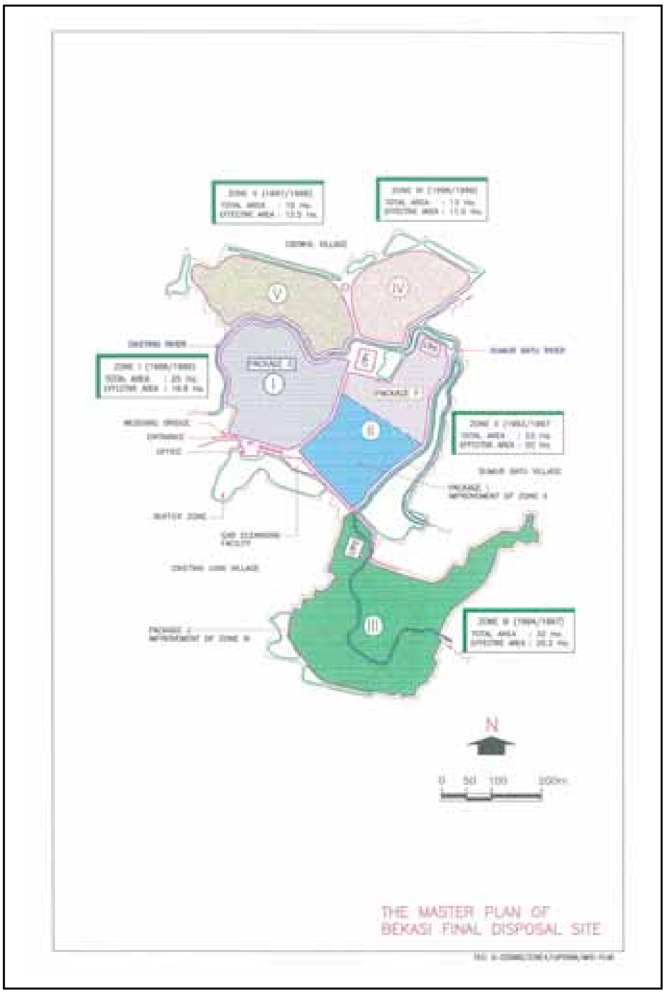


Figure-2 Project Area Map

A.4.2. Category(ies) of project activity:

Landfill gas recovery and conversion to electricity

A.4.3. Technology to be employed by the project activity:

The project will involve proven technology and hardware for the recovery, collection and treatment of landfill gas (LFG) and power generation by utilizing gas. In addition, since gas recovery volume is essential to the project viability, optimization of gas recovery wells arrangement in the disposed waste is made by applying a newly developed method based on the site investigation.

The facilities proposed for the project consist of an LFG recovery system, an LFG treatment system, and an LFG power generation system as shown in Figure-3. The details of each system follow.

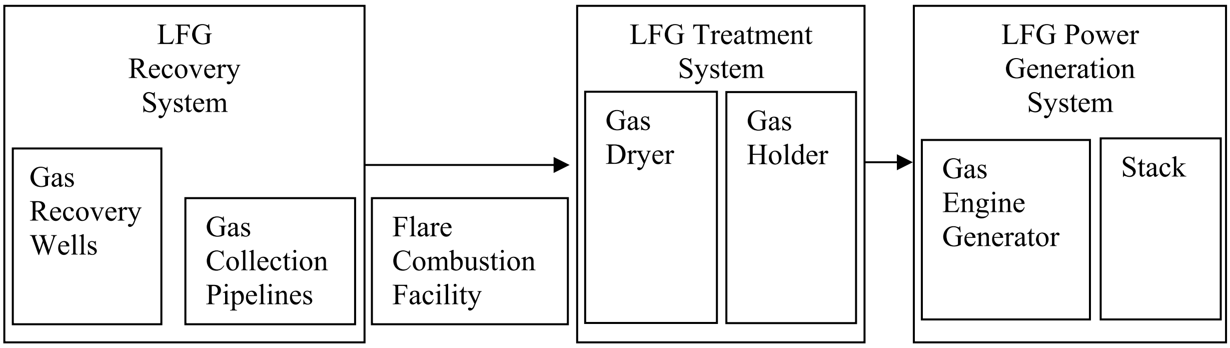


Figure-3 Overview flowchart of the LFG facility

LFG recovery system

It is noted that a critical factor that controls methane gas emissions is a covering layer of the landfill surface as well as recovery wells. In order to maximize the methane gas recovery, the landfill area of the project will be covered with density soil of thickness more than 0.3m.

In the LFG recovery system, LFG is collected through gas recovery wells located at the landfill area and conveyed to LFG treatment system and power generation system by LFG collection pipelines.

LFG treatment system

The LFG treatment system brings LFG to an appropriate state for the LFG power generation plant. With a gas dryer, it reduces moisture content of the gas suitable to gas engine combustion.

LFG power generation system

Gas engine generators combust the gas as fuel and generate electricity. All the electric power generated by the facility excluding its in-house consumption is sold to Perusahaan Listrik Negara (PLN), Indonesia's state-run electricity company, which owns and controls all public electricity infrastructure in Indonesia, including power generation, transmission, distribution and retail sale of electricity, and a regional power generator and distributor.

The voltage of the generated electricity is stepped up from 380V to 20KV at the project site and transferred to the PLN sub-station nearby.

Flare combustion facility

The flare combustion facility burns excessive LFG beyond the gas engine capacity and colleted LFG during maintenance (inspection and malfunction) of the gas engine generators.

Facilities in summary

In summary, the following components are installed in the LFG recovery and power generation facilities:

- ►Approximately 120 vertical wells with perforated PVC pipe casing
- ►Horizontal PVC pipeline system conveying the collected LFG
- ►A Flare stack
- ►A gas dryer (dehumidification)
- ►A gas holder (LFG storage)
- ►Gas engine generators
- ►A flue gas exhaust stack
- ►Step-up transformers
- ►Transmission line to the grid
- ►Monitoring equipment

The technology employed is environmentally sound, because almost no alteration is added to the present state of landfill site except boring the vertical holes of small size.

A.4.4. Brief explanation of how the anthropogenic emissions of anthropogenic greenhouse gas (GHGs) by sources are to be reduced by the proposed CDM project activity, including why the emission reductions would not occur in the absence of the proposed project activity, taking into account national and/or sectoral policies and circumstances:

Approx. 90 percent of landfill sites operated in Indonesia are open-dumping sites, most of which assume anaerobic systems. No incineration treatment facility has been introduced in Indonesia, and a great amount of LFG, which contains methane as Greenhouse Gas (GHG), is emitted from the landfills in Indonesia. Banter Gebang Landfill, the project site, is one of such landfill sites.

In Banter Gebang Landfill site, waste from DKI Jakarta is received and disposed. LFG generated in the landfill has never been collected. Consequently, the landfill is diffusing LFG including methane gas, which shows high coefficient of greenhouse effect. The remaining life of the landfill operation there is predicted two years from now. However, the LFG recovery is not planned for its safety closure.

The waste management department of DKI Jakarta, however, indicated that Banter Gebang site would continue to be operated for the time being, because there are no other landfill sites receiving municipal waste of DKI Jakarta and it is difficult to locate new landfill sites nearby. The recent study indicated that the Banter Gebang site could expand its capacity up to 145M m^3 (approximately twice as much as original capacities) by compacting existing layer and dumping over existing layers.

Table-1 shows current operation of the Banter Gebang site, and Table-2 shows annual waste volumes deposited into each zones of the Banter Gebang Site.

Table- 1 Current Operation of Banter Gebang Site

Zone	Area (ha)	Status	Remarks
Zone Ⅰ	25	Operating	• Compacting existing layers and dumping over them. • Expand the capacity up to Approx. twice.
Zone Ⅱ	23	Will be operating	
Zone Ⅲ	31	Will be operating	
Zone Ⅳ	14	Final Closing	4 monitoring wells for measurement
Zone Ⅴ	15	Temporary Closing	1 monitoring wells for measurement

Table- 2 Annual Waste Volumes Deposited to Banter Gebang Site

(m^3)

	Zone Ⅰ	Zone Ⅱ	Zone Ⅲ	Zone Ⅳ	Zone Ⅴ	Total
1989	5,475,000					5,475,000
1990	5,490,000					5,490,000
1991		5,475,000				5,475,000
1992		6,205,000				6,205,000
1993		6,205,000				6,205,000
1994			6,205,000			6,205,000
1995			6,222,000			6,222,000
1996			6,205,000			6,205,000
1997				6,570,000		6,570,000
1998				6,570,000		6,570,000
1999				6,570,000		6,570,000
2000					6,588,000	6,588,000
2001					6,935,000	6,935,000
2002	6,935,000					6,935,000
2003		2,282,438	3,234,098	1,418,464		6,935,000
2004*	1,138,438		1,650,404		650,158	3,439,000
Total	19,038,438	20,167,438	23,516,502	21,218,464	14,173,158	98,024,000

(Data Source：Cleaning Department, DKI Jakarta)
*Deposited volume for 2004 shows an interim volume

The annual amount of solid waste deposited into Zone IV and Zone V has been recorded by DKI Jakarta as shown in Table-2 above.

If the methane gas were not collected, it would diffuse to the atmosphere to increase greenhouse effect even after the closure of the site. On the other hand, the project collects and consumes methane gas with gas engine generators to generate electricity. Since this renewable energy will replace the electricity generated by conventional fuel based generators, carbon dioxide from the said generation is also reduced.

It is unlikely that any countermeasures for preventing methane emission from the landfill site will be planned and installed without CDM projects in Indonesia, because the Indonesia Government has many other important public projects with higher priority, and this project does not seem to be economically feasible without the carbon credits.

The state Ministry of Environment issued the national policy toward CDM projects, suggesting four sustainability criteria; economical, environmental, social, and technical. Proposed CDM projects in Indonesia are to satisfy these criteria.

The proposed project also contributes to safety closure of a landfill site, promotion of renewable energy use, and sustainable development as well as reducing GHG emission.

A.4.4.1. Estimated amount of emission reductions over the chosen crediting period:

Based on the waste volumes listed on Table-2, the annual landfill gas generation was calculated by the First Order Decay Model (the IPCC Guidelines for National Greenhouse Gas Inventories Volume 3: Reference Manual (1996),Chapter 6). Parameters necessary for calculating gas volume are determined based on the result of sample tests of waste and gas measurement at the site as shown in Table-3.

Table-3 Parameters for Gas Volume Estimation

Total Organic Carbon in Waste (TOCO)	80.00	kg/t
Decay Rate (k value)	0.15	/yr
Methane Concentration in Landfill Gas (CH4)	50	%
Methane Gas Potential (Ge)	146.45	m^3/t
Temperature	50	℃
Borehole Diameter	0.07	m
Average Velocity	0.93	m/s
Number of Boreholes	120	-

The following Table-4 shows annual gas emission volume and GHG reduction in terms of CO_2 tonnage.

Table-4 Annual Gas Generation and GHG Reduction

	LFG Emission Vol. (m^3/day)	CH_4 Emission (m^3/day)	CH_4 Capture (m^3/day)	CO_2 Reduction (ton/yr)	CO_2 Emission by Baseline (ton/yr)	CO_2 Emission by Project (ton/yr)
2008	195,765	97,883	28,044	153,538	535,907	382,369
2009	168,497	84,248	26,641	145,861	461,260	315,398
2010	145,026	72,513	25,239	138,184	397,010	258,825
2011	124,825	62,413	23,837	130,508	341,710	211,202
2012	107,438	53,719	22,435	122,831	294,112	171,281
2013	92,473	46,236	21,033	115,154	253,145	137,991
2014	79,592	39,796	19,630	107,477	217,884	110,407
2015	68,506	34,253	18,228	99,800	187,534	87,734
2016	58,963	29,482	16,826	92,123	161,412	69,289
2017	50,750	25,375	15,424	84,446	138,929	54,483

A.4.5. Public funding of the project activity:

No Official Development Assistance (ODA) funding will be provided.

SECTION B. Application of a baseline methodology

B.1. Title and reference of the approved baseline methodology applied to the project activity:

The Baseline Methodology used is ACM0001 "Consolidated baseline methodology for landfill gas project activities."

B.1.1. Justification of the choice of the methodology and why it is applicable to the project activity:

ACM0001 can be applied to a project that claims emission reductions for displacing or avoiding energy from other sources.

The proposed project is defined as follows:

- To collect landfill gas from a closed landfill.
- To generate electricity using collected landfill gas.
- To flare excess landfill gas.

The proposed project claims emission reduction for the captured landfill gas and for displacing electricity from other sources.

The Baseline Methodology ACM0001 is applicable to landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as:
a) The captured gas is flared; or
b) The captured gas is used to produce energy (e.g. electricity/thermal energy), but no emission reductions are claimed for displacing or avoiding energy from other sources[1]; or
c) The captured gas is used to produce energy (e.g. electricity/thermal energy), and emission reductions are claimed for displacing or avoiding energy generation from other sources. In this case a baseline methodology for electricity and/or thermal energy displaced shall be provided or an approved one used, including the ACM0002 "Consolidated Methodology for Grid-Connected Power Generation from Renewable." If capacity of electricity generated is less than 15MW, and /or thermal energy displaced is less than 54 TJ (15GWh), small-scale methodologies can be used. This baseline methodology shall be used in conjunction with the approved monitoring methodology ACM0001 ("Consolidated monitoring methodology for landfill gas project activities").

The proposed project meet the third condition. Because the captured gas is used to produce electricity, and emission reductions are claimed for displacing grid electricity.

Justification of the method's appropriateness considering the project circumstances is given below.

B.2. Description of how the methodology is applied in the context of the project activity:

The baseline approach adopted by this methodology is EB 16 Report Annex 1 "Tool for the demonstration and assessment of additionality."
This approach provides for a step-wise approach to demonstrate and assess additionality. These steps include:

- Identification of alternatives to the project activity;
- Investment analysis to determine that the proposed project activity is not the most economically or financially attractive;
- Barriers analysis;
- Common practice analysis; and
- Impact of registration of the proposed project activity as a CDM project activity.

The economic attractiveness of alternatives are evaluated with IRR without revenue from carbon credits (CERs) compared with a reasonable expected return on investment in Indonesia.
Barriers analysis is the process of identifying barriers that would prevent the implementation of proposed type of the alternatives.
Based on information about activities similar to the proposed project activity, the common practice analysis is to complement and to reinforce the investment and barriers analysis.
Figure-4 shows outlines of demonstrating additionality.

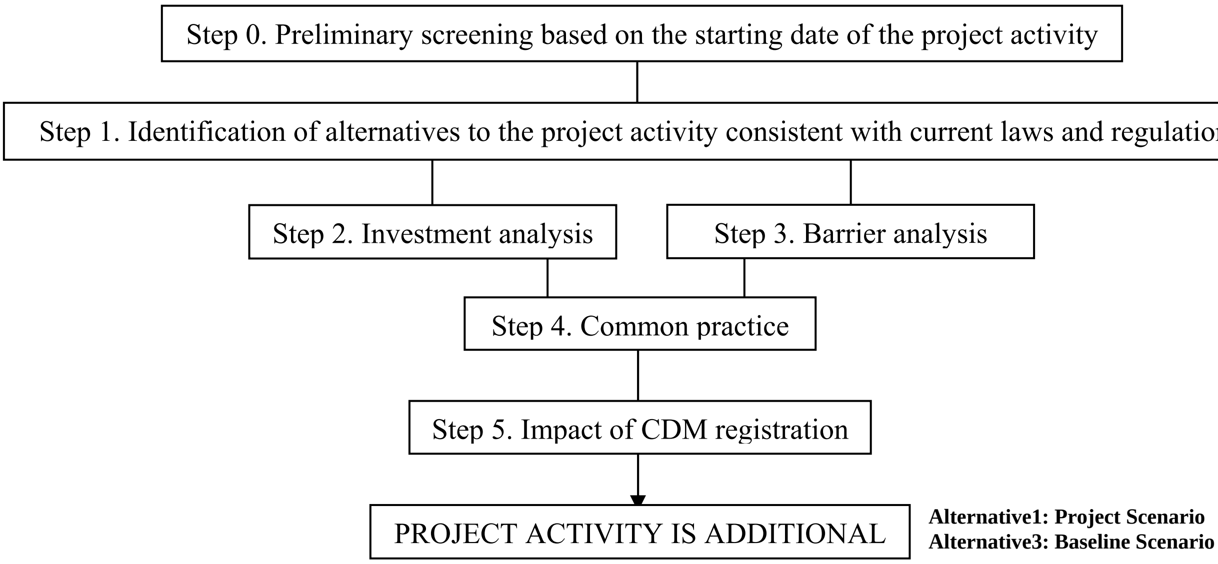


Figure-4 Flowchart of Additionality Scheme

The following paragraphs describe how the proposed baseline methodology is applied to single out the baseline scenario for the proposed project, and prove that the proposed project is additional. As mentioned above, we here demonstrate the project additionality according to the EB16 Report Annex 1 "tools for the demonstration and assessment of additionality."

<u>Step 0:</u> Preliminary screening based on the starting date of the project activity
The proposed CDM project won't claim the credits before the registration. We therefore skip this step.

<u>Step 1:</u> Identification of alternatives to the project activity consistent with current laws and regulations

Landfill (open dumping) is a generally accepted solid waste management system in Indonesia.
Composting system has also now started to be introduced tentatively. It is however still experimental phase. Small-scale composting pilot plants cannot be an alternative waste management system.
As for incineration system, Surabaya city introduced its own incinerator with 200t/day capacity in 1991. They however stopped the operation of the incinerator in 1998 due to rising cost of waste disposal.
Taking local situations and contribution to sustainable development into account, we propose three plausible scenarios for safety closure of landfill sites and valid use of solid wastes as follows.

Sub-step 1a. Define alternatives to the project activity:

Alternative 1: Generating electricity by landfill gas (Proposed project)

- In this alternative, a landfill is closed with soil cover and biogas is captured through vertical pipes deeply installed into a landfill. Electricity is generated by collected landfill gas (biogas). The project will involve proven technology and hardware for recovery, collection and treatment of landfill gas (LFG) and power generation by utilizing gas.
- Several projects of same kind have been already executed in many countries although they are not CDM projects. Actually in 2003, Directorate of Urban and Rural Development, Ministry of Settlement and Regional Infrastructure proposed a pilot project of landfill gas utilization in Banter Gebang landfill site.
- There are many pilot plans for gas utilization and executed in many countries. LFG projects also could contribute to local sustainability by improving local environment.

Alternative 2: Soil covering with flaring gas

- In this alternative, a landfill is closed with soil cover and biogas is captured through vertical pipes deeply installed into a landfill. Captured gas is flared by burners, instead of generating electricity.
- This alternative is applied just for safety operation of landfill sites. This alternative cannot control methane gas emitted from landfill site or accelerate producing biogas.
- There are some techniques required to maintain pilot burners safely and to operate burning systems as a whole.
- This alternative yields no profit except CERs.

Alternative 3: Soil covering with installing shallow vertical pipes

- Almost all landfill sites in Indonesia have no special treatment for closing sites. There are no enforcement or guidelines for regulating safety closure of landfill sites.
- It is unlikely that safety closure of landfill would be achieved by voluntary control.
- However, as for Zone IV and Zone V of the Banter Gebang site, a landfill is closed with soil cover and shallow vertical pipes are installed for stabilizing landfill sites, in other word, enhancing aerobic reaction. Emitted landfill gas is not captured nor flared.
- Although this closure treatment is not commonly used in Indonesia, this treatment is sometimes used for safety closure of open-dumping landfill sites in many other countries.

Sub-step 1b. Enforcement of applicable laws and regulations:

There are no official enforcements or guidelines regulating biogas emitted from landfill sites. Moreover, there are no regulations for closure treatment. Therefore almost all landfill sites of the same kind in Indonesia have no soil covering. (Only Zone IV and Zone V in the Banter Gebang landfill site have soil covering.)

We apply Step2 investment analysis for Alternative1 and Alternative2,

Step 2. Investment analysis

Sub-step 2a. Determine appropriate analysis method

We here apply simple cost analysis for Alternative 2 and apply benchmark analysis for Alternative 1.

Sub-step 2b. – Option I. Apply simple cost analysis

Alternative 2 produces no economic benefits other than CERs in spite of some additional cost for burning equipment and operating cost. It is quite clear that Alternative2 is not financially attractive.

Sub-step 2b – Option III. Apply benchmark analysis

Based on the ex-ante estimation of gas emission volume analysed by site measurement and laboratory sample tests, we evaluated gas emission volume and evaluated the economic feasibility of Alternative 1 by IRR.

According to the data of BANK INDONESIA, the interest rate of Indonesian government bond due to 2017 is 8.3-8.4%. Taking a risk premium to reflect private investment without governmental support into account, it is unlikely that private projects whose IRRs are under 8.4% would be put into practice. Cash flow analysis of Alternative 1 indicated that the project IRR for ten years without CERs turned out to be negative (-12%). Obviously Alternative 1 is financially unattractive course of action. Therefore Alternative 1 is additional and cannot be a baseline scenario. (See Annex 3)

The only revenue generated by the Alternative1 is the sale of electricity. The following conditions were set for the IRR calculations.

- Electricity sale price: 0.04 US$/kWh
- Inflation Rate: 5.78%
- Corporate Tax: 30%

Sub-step 2c. Calculation and comparison of financial indicators (only applicable to options II and III):

Comparing Alternative 1 and Alternative 2, Alternative 2 won't produce any profit other than CERs. There is no income from the project except CERs. From the financial point of view, therefore Alternative 1 is more plausible scenario.

Step 3. Barrier analysis

There are no regulations or guidelines prohibiting any alternatives we proposed. However, flaring system is undesirable for energy saving thus Alternative 2 is not a suitable scenario in light of sustainable development.

Step 4. Common practice analysis

As for Alternative1, the proposed pilot project mentioned above (step1) has not been put into practice (because of economic feasibility) yet. This fact clearly proves that Alternative1 is not a common practice.

As for Alternative2, there are no landfill sites flaring biogas from gas collecting wells in Indonesia. Therefore Alternative2 is not a common practice.

As for Alternative3, Almost all landfill sites in Indonesia have no special treatment for closing sites. There are no enforcement and guidelines for regulating safety closure of landfill sites. However, only Zone IV and Zone V of the Banter Gebang landfill site are soil-covered so far in Indonesia. Other ordinal landfill sites have no special closure treatment. Although Alternative3 is not a common practice for ordinary landfill sites in Indonesia, the project site (Zone IV and Zone V of the Banter Gebang site) has already been soil-covered. As far as this project, therefore Alternative3 will be a common practice.

Step 5. Impact of CDM registration

There are a large number of open dumping landfill sites in Indonesia such as Banter Gebang landfill site. Appropriate closure treatment and valid use of collected biogas from landfill sites will contribute to not only preventing global warming but also improving local environment. Moreover, spread of this kind of project will contribute to technological sustainability as well as environmental sustainability determined as Indonesian environmental policy.

Although Alternative1 is not a financially attractive course of action as well as Alternative2, according to the analysis stated above, Alternative2 is not likely to be a reasonable scenario. We therefore defined Alternative 1 as a project scenario and Alternative 3 as a baseline scenario.

B.3. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity:

The proposed project scenario is based on the collection of the landfill gas and its combustion for the generation of electricity. Combustion of the landfill gas to produce electricity will convert the highly potent methane content to less potent carbon dioxide, and result in significant greenhouse gas emission reductions.

Emission Reduction

The greenhouse gas emission reduction achieved by the project activity during a given year "y" (**ER_y**) is the difference between the amount of methane actually destroyed/combusted during the year (**$MD_{project,y}$**) and the amount of methane that would have been destroyed/combusted during the year in the absence of the project activity (**$MD_{reg,y}$**), times the approved Global Warming Potential value for methane (**GWP_{CH4}**), plus the net quantity of electricity displaced during the year (**EG_y**) multiplied by the CO_2 emissions intensity of the electricity displaced (**$CEF_{electricity,y}$**)

$$ER_y = \left(MD_{project\,y} - MD_{reg\,y}\right) * GWP_{CH4} + EG_y * CEF_{electricit\,y,\,y} \quad (1)$$

ER_y is measured in tonnes of CO_2 equivalents (tCO_2e). **$MD_{project,y}$** and **$MD_{reg,y}$** are measured in tonnes of methane (tCH_4). The approved Global Warming Potential value for methane (**GWP_{CH4}**) for the first commitment period is 21 tCO_2e/tCH_4. EG_y is measured in megawatt hours (MWh). The CO_2 emissions intensity, **$CEF_{electricity,y}$**, is measured in tonnes of CO_2 equivalents per megawatt hour (tCO_2e/MWh) and **ET_y** is measured in TeraJoules (TJ).

In the case where the **$MD_{reg,y}$** is given/defined as a quantity that quantity will be used.

In cases where regulatory or contractual requirements do not specify $\mathbf{MD_{reg,y}}$ an “Adjustment Factor” (AF) shall be used and justified, taking into account the project context.
Since there is no enforcement regulating LFG emission in Indonesia, AF turned out to be 0. Therefore,

$$\mathbf{MD_{reg,\ y} = MD_{project,\ y} * AF = 0} \quad (2)$$

Project proponents should provide an ex ante estimate of emissions reductions, by projecting the future GHG emissions of the landfill. In doing so, verifiable methods should be used. Ex ante emission estimates may have an influence on $\mathbf{MD_{reg,y}}$. $\mathbf{MD_{project,y}}$ will be determined ex post by metering the actual quantity of methane captured and destroyed once the project activity is operational.
The methane destroyed by the project activity ($\mathbf{MD_{project,y}}$) during a year is determined by monitoring the quantity of methane actually flared and gas used to generate electricity.

$$\mathbf{MD_{project,\ y} = MD_{flared,\ y} + MD_{electricity,\ y}} \quad (3)$$

$$\mathbf{MD_{flared,\ y} = LFG_{flare,\ y} * w_{CH4,\ y} * D_{CH4} * FE} \quad (4)$$

Where $\mathbf{MD_{flared,y}}$ is the quantity of methane destroyed by flaring, $\mathbf{LFG_{flare,y}}$ is the quantity of landfill gas flared during the year measured in cubic meters (m^3), $\mathbf{w_{CH4,y}}$ is the average methane fraction of the landfill gas as measured during the year and expressed as a fraction (in m^3 CH_4 / m^3 LFG), **FE** is the flare efficiency (the fraction of the methane destroyed) and $\mathbf{D_{CH4}}$ is the methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/ m^3 CH_4).

$$\mathbf{MD_{electricit\,y,\ y} = LFG_{electricity,\ y} * w_{CH4,\ y} * D_{CH4}} \quad (5)$$

where $\mathbf{MD_{electricity,y}}$ is the quantity of methane destroyed by generation of electricity and $\mathbf{LFG_{electricity,y}}$ is the quantity of landfill gas fed into electricity generator.

Project Boundary

The project boundary is the site of the project activity where the gas is captured and destroyed/used.
Possible CO_2 emissions resulting from combustion of other fuels than methane recovered should be accounted as project emissions. Such emissions may include fuel combustion due to pumping and collection of landfill gas or fuel combustion for transport of generated heat to the consumer locations.
In addition, electricity required for the operation of the project activity, including transport of heat, should be accounted and monitored. Where the project activity involves electricity generation, only the *net* quantity of electricity fed into the grid should be used in equation (1) above to account for emission reductions due to displacement of electricity in other power plants.

Table- 5 Percentage of PLN electricity generated by sources in 2000

Crude oil	Coal	Natural gas	Hydro	Others	Total(GWh)
14.0	34.5	5.8	10.9	34.8	83,5004

Table- 6 Emission factors by sources in Japan (kg CO2e/kWh)
(Data Source: Central Research Institute of Electric Power Industry of Japan)

Crude oil	Coal	Natural gas	Hydro	Others
0.742	0.975	0.608	0.011	0.020(estimated)

Using those data in Table-5 and Table-6, the weighted average emission is 0.484 kg

CO_2e/kWh.

Applying the Gas Generation Potential Model and the First Order Decay Model with parameters whose values are determined by the site investigation, it is estimated that only 1.80 million tones of CO_2e will be emitted as fugitive emissions in the proposed project scenario during the period 2008-2017 compared to 2.99 million tCO_2e in the baseline scenario. Detailed computational steps and some data are summarized in Annex 3.

Emission reduction by displacing the grid electricity by the amount corresponding to the electricity generated by the proposed project is calculated by the baseline methodology explained above, and 0.08 million tones of CO_2e, will be destroyed.

B.4. Description of how the definition of the project boundary related to the baseline methodology selected is applied to the project activity:

A full flow diagram of the proposed project and system boundaries is presented in Figure-5. The flow diagram comprises all possible elements of the landfill gas collection system and the equipment for electricity generation.

The proposed project will be implemented inside the landfill after the landfill is closed, making the project a closed system that does not stimulate off-site emissions. Then no leakage is considered to be likely in this proposed project.

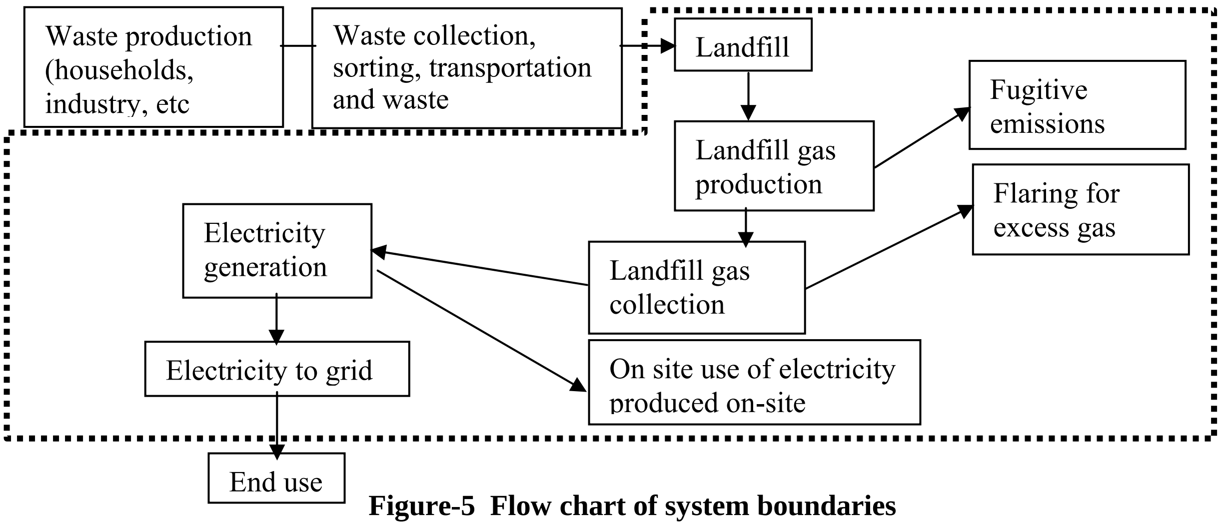


Figure-5 Flow chart of system boundaries

Table-7 contains a summary of the system and project boundaries for the proposed project.

Table-7 Summary of System and Project Boundaries

Activities		Source	Gas	Remarks
Baseline	Direct onsite	Landfill gas	CH_4	Considered
			CO_2	Carbon neutral
	Direct offsite	Fuel combustion for grid power	CO_2	Considered
			N_2O	Not considered on conservative side
Project	Direct onsite	Landfill gas	CH_4	Considered
			CO_2	Carbon neutral
		LFG combustion	CO_2	Carbon neutral

		for power	N_2O	Negligible
		Battery use for start-up	CO_2	Nominal (ignored)
		Project Operation	CO_2	Electricity by LFG used and carbon neutral

B.5. Details of baseline information, including the date of completion of the baseline study and the name of person (s)/entity (ies) determining the baseline:

B.5.1. Date of completing the final draft of this baseline section

31/03/2005

B.5.2. Name of person/entity determining the baseline:

Hiroaki Tanabe
Kajima Corporation
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Minato-ku
Tokyo 107-8502
Japan
Telephone: +81-3-6229-6730
Fax: +81-3-5561-2153
E-mail: tanabeh@kajima.com

SECTION C. Duration of the project activity / Crediting period

C.1 Duration of the project activity:

C.1.1. Starting date of the project activity:

Estimated as 01/01/2008

C.1.2. Expected operational lifetime of the project activity:

10 years

C.2 Choice of the crediting period and related information:

By moving its gas recovery zones within whole Bantar Gebang landfill site, the project activities will be carried out continuously. Therefore, the operational lifetime of the project activity might be modified according to the landfill operation hereafter.

In this document, we evaluated the project feasibility focusing on Zone IV and Zone V for ten years. However, three renewable crediting period of 7 years shall be applied if the condition for replacement of recovery site allows.

C.2.1. Renewable crediting period

C.2.1.1. Starting date of the first crediting period:

C.2.1.2. Length of the first crediting period:

C.2.2. Fixed crediting period:

C.2.2.1. Starting date:

01/01/2008

C.2.2.2. Length:

10 years.

SECTION D. Application of a monitoring methodology and plan

D.1. Name and reference of approved monitoring methodology applied to the project activity:

The approved consolidated monitoring methodology ACM0001 “Consolidated monitoring methodology for landfill gas project activities” is applied to the project.

D.2. Justification of the choice of the methodology and why it is applicable to the project activity:

The applicability for this methodology is described as follows.

This methodology is applicable to landfill gas capture project activities, where the baseline scenario is the partial or total atmospheric release of the gas and the project activities include situations such as:

a) The captured gas is flared; or
b) The captured gas is used to produce energy (e.g. electricity / thermal energy), but no emission reductions are claimed for displacing or avoiding energy from other sources; or
c) The captured gas is used to produce energy (e.g. electricity / thermal energy), and emission reductions are claimed for displacing or avoiding energy from other sources

The item c) is applicable to this project because this project aims for landfill gas recovery and electricity generation with the green house gas emission reduction components below where the baseline scenario is the total atmospheric release of the gas:
►Conversion to CO_2 of the methane in the landfill gas
►Displacement of grid electricity with the electricity generation by landfill gas

According to the approved monitoring methodology ACM0001, the monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform and the electricity generating units to determine the quantities. In the case of the proposed CDM project activity, the direct measurements same as the applied methodology will be done as proposed in the monitoring plan.

D.2. 1. Option 1: Monitoring of the emissions in the project scenario and the baseline scenario

Not applicable

D.2.1.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:

ID number *(Please use numbers to ease cross-referencing to D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c) or estimated (e)	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment
1			*ppm*	m				
2				m				

Not applicable

D.2.1.2. Description of formulae used to estimate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

Not applicable

D.2.1.3. Relevant data necessary for determining the baseline of anthropogenic emissions by sources of GHGs within the project boundary and how such data will be collected and archived :

ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording Frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Not applicable

D.2.1.4. Description of formulae used to estimate baseline emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

Not applicable

D. 2.2. Option 2: Direct monitoring of emission reductions from the project activity (values should be consistent with those in section E).

Attention to the future regulation and/or law applicable to collection and capture of LFG

At the time of PDD preparation, there neither exist nor are foreseen any regulations or laws requiring collection and capture of GHG from landfill site in Indonesia. Future regulations and/or laws applicable to the LFG collection and capture will be monitored throughout the project period and will be followed as required.

Measurement of LFG

The monitoring methodology is based on direct measurement of the amount of landfill gas captured and destroyed at the flare platform and the electricity generating energy unit(s) except CO_2 emissions intensity ($CEF_{electricity,y}$), which will be obtained from the latest available annual report issued by PLN. The monitoring plan provides for continuous measurement of the quantity and quality of LFG flared and the electricity energy generated. The main variables that need to be determined are the quantity of methane actually captured $MD_{project,y}$, quantity of methane flared ($MD_{flare,y}$) and the quantity of methane used to generate electricity ($MD_{electricity,y}$) determined as follows:

Methane collected and flared

The amount of methane actually flared ($MD_{flare,y}$) will be determined by monitoring.

► Amount of landfill gas flared ($LFG_{flare,y}$) [m^3 - using a continuous flow meter].

► Methane fraction in the landfill gas (F_CH_{4y}) [m^3CH_4/m^3LFG - using a continuous gas quality analyzer].

► Flare/combustion efficiency [% - determined by the operation hours and the methane content in the exhaust gas].

- Flare working hours [hours - using a run time meter].
- Methane content in the exhaust gas [m^3CH_4/m^3 - using a continuous gas quality analyzer].

► Density of methane [tCH_4/m^3CH_4 - determined by the temperature and pressure of the landfill gas].

- Temperature of the landfill gas [℃ - using a thermometer].
- Pressure of the landfill gas [Pa - using a manometer].

Methane collected and used to generate electricity

The amount of methane actually combusted in power plant shall be determined by monitoring.

► Amount of landfill gas combusted in power plant ($LF_{Gelectricity,y}$) [m^3 - using a continuous flow meter].

► Methane fraction in the landfill gas (F_CH_{4y}) [m^3 - using a continuous gas quality analyzer].

► Density of methane [tCH_4/m^3CH_4 - determined by the temperature and pressure of the landfill gas].

- Temperature of the landfill gas [℃ - using a thermometer].
- Pressure of the landfill gas [Pa - using a manometer].

Displacement of grid electricity with the electricity generation by landfill gas

The amount of electricity transferred (= displaced) to the grid and used to operate the landfill project will be directly measured by monitoring.

► Amount of electricity generation ($EG_{total,y}$) [MWh - using a continuous power meter].

► Amount of displaced electricity (EG_y) [MWh - using a continuous power meter].

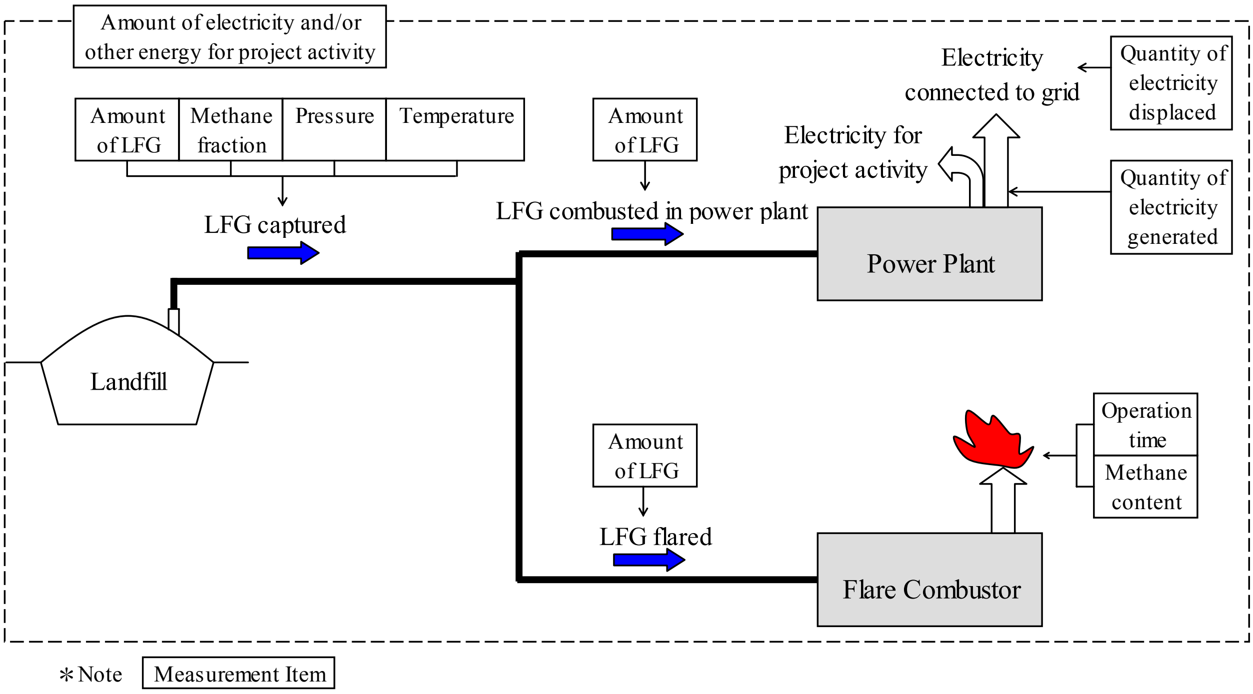

Figure-6 Schematic of monitoring

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:								
ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated (c), estimated (e),	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic / paper)	Comment
1	*LFGtotal,y*	*Total amount of landfill gas captured*	m^3	*m*	*Continuous*	*100%*	*electronic*	*Measured by a flow meter. Data to be aggregated monthly and yearly*
2	*LFGflare,y*	*Amount of landfill gas flared*	m^3	*m*	*Continuous*	*100%*	*electronic*	*Measured by a flow meter. Data to be aggregated monthly and yearly*
3	*LFGelectricity,y*	*Amount of landfill gas combusted in power plant*	m^3	*m*	*Continuous*	*100%*	*electronic*	*Measured by a flow meter. Data to be aggregated monthly and yearly*
4	*FE*	*Flare/combustion efficiency, determined by (1) the operation hours and (2) the methane content in the exhaust gas*	*%*	*m/c*	*(1)Continuous (2)Quarterly, monthly if unstable*	*n/a*	*electronic*	*(1)Continuous measurement of operation time of flare (e.g. with temperature) (2)Periodic measurement of methane content of flare exhaust gas.*
5	*w_CH4,y*	*Methane fraction in the landfill gas*	m^3CH_4/m^3LFG	*m*	*Continuous*	*100%*	*electronic*	*Measured by continuous gas quality analyser*
6	*T*	*Temperature of the landfill gas*	℃	*m*	*Continuous*	*100%*	*electronic*	*Measured by continuous thermometer. Measured to determine the density of methane* D_{CH4}
7	*P*	*Pressure of the landfill gas*	*Pa*	*m*	*Continuous*	*100%*	*electronic*	*Measured by continuous manometer. Measured to determine the density of methane* D_{CH4}

D.2.2.1. Data to be collected in order to monitor emissions from the project activity, and how this data will be archived:								
8	*Etotal,y*	*Total amount of electricity and/or energy carriers used in the project for gas pumping and heat transport(not derived from the gas)*	*MWh*	*m/c*	*Continuous*	*100%*	*electronic*	*Electricity for project activity is the difference between the quantity of electricity generated and the quantity of electricity displaced (= electricity transferred to the PLN grid).* *There is no significant consumption of other energy for project activity.* *Required to determine CO_2 emissions from use of electricity to operate the project activity*
9	*CEFenergy,y*	*CO2 emission intensity of the electricity and/or other energy carriers in ID8*	*tCO_2/ MWh*	*c*	*Annually*	*100%*	*electronic*	*Required to determine CO_2 emissions from use of electricity or other energy carriers to operate the project activity*
10	*EGtotal,y*	*Quantity of electricity generated*	*MWh*	*m*	*Continuous*	*100%*	*electronic*	*Measured by continuous power meter*
11	*EGy*	*Quantity of electricity displaced*	*MWh*	*m*	*Continuous*	*100%*	*electronic*	*Measured by continuous power meter installed and controlled by PLN*

D.2.2.2. Description of formulae used to calculate project emissions (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.):

The formulae used to calculate project emission reduction is:

$$Er_y = (Md_{project,y} – Md_{reg,y}) \times GWP\_CH_4 + EG_y \times CEF_{electricity,y}$$

Where:

y : Duration of the project activity, 10 years

Er_y : Greenhouse gas emission reduction measured in tonnes of CO2 equivalents (tCO_2e)

$Md_{project,y}$: Amount of methane actually combusted measured in tonnes of methane (tCH_4)

$Md_{reg,y}$: Amount of methane that would have been combusted during the absence of the project activity measured in tonnes of methane (tCH_4) and currently $Md_{reg,y}$= zero
GWP_CH_4 : Approved Global Warming Potential value for methane (GWP_{CH4}) for the first commitment period is 21 tCO2e/tCH4
EG_y : Quantity of electricity displaced measured in mega watt hour (MWh)
$CEF_{electricity,y}$: CO2 intensity of the electricity displaced expressed in tonnes of CO2 equivalents per mega watt hour (tCO2e/MWh)

$Md_{projecy,y}$ is sum total $Md_{electricity}$ and $Md_{flare,y}$ as follows.

$$Md_{project,y} = Md_{electricity,y} + Md_{flare,y}$$

and each formulae used to calculate $Md_{electricity,y}$ and $Md_{flare,y}$ is as follows.

$$Md_{electricity,y} = LFG_{electricity,y} \times w_{CH4,y} \times D_{CH4}$$

Where:
$LFG_{electricity,y}$: Quantity of landfill gas combusted in power plant measured in cubic meters (m^3)
$w_{CH4,y}$: Methane fraction of the landfill gas measured in cubic meters of methane per cubic meters of landfill gas (m^3CH_4/m^3LFG)
D_{CH4} : Methane density expressed in tonnes of methane per cubic meter of methane ($tCH_4/m^3\ CH_4$) and determined by temperature and pressure of LFG

$$Md_{flare,y} = LFG_{flare,y} \times w_{CH4,y} \times D_{CH4} \times FE$$

Where:
$LFG_{flare,y}$: Quantity of landfill gas flared measured in cubic meters (m^3)
$w_{CH4,y}$: Methane fraction of the landfill gas measured in cubic meters of methane per cubic meters of landfill gas (m^3CH_4/m^3LFG)
D_{CH4} : Methane density expressed in tonnes of methane per cubic meter of methane ($tCH_4/m^3\ CH_4$) and determined by temperature and pressure of LFG
FE : Flare efficiency is expressed in percentage (%) and determined by the operation hours of flare combustion and the methane content in flare exhaust gas

D.2.3. Treatment of leakage in the monitoring plan **D.2.3.1. If applicable, please describe the data and information that will be collected in order to monitor leakage effects of the project activity**								
ID number *(Please use numbers to ease cross-referencing to table D.3)*	Data variable	Source of data	Data unit	Measured (m), calculated or estimated (e)	Recording frequency	Proportion of data to be monitored	How will the data be archived? (electronic/ paper)	Comment

Not applicable

D.2.3.2. Description of formulae used to estimate leakage (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

As shown in the baseline study, leakage is not likely. Data on this will be therefore not collected.

D.2.4. Description of formulae used to estimate emission reductions for the project activity (for each gas, source, formulae/algorithm, emissions units of CO_2 equ.)

See item A.4.4.1 for the full explanation

D.3. Quality control (QC) and quality assurance (QA) procedures are being undertaken for data monitored		
Data *(Indicate table and ID number e.g. 3.-1.; 3.2.)*	Uncertainty level of data (High/Medium/Low)	Explain QA/QC procedures planned for these data, or why such procedures are not necessary.
1-3.LFGy	*Low*	*Flow meters should be subject to a regular maintenance and testing regime to ensure accuracy.*
4.FE	*Medium*	*Regular maintenance should ensure optimal operation of flares. Flare efficiency should be checked quarterly, with monthly checks if the efficiency shows significant deviations from precious values.*
5. w_CH4,y	*Low*	*The gas analyser should be subject to a regular maintenance and testing regime to ensure accuracy.*
6.T	*Low*	*The thermometer should be subject to a regular maintenance and testing regime to ensure accuracy.*
7.P	*Low*	*The manometer should be subject to a regular maintenance and testing regime to ensure accuracy.*
10-11.EG	*Low*	*The power meter should be subject to a regular maintenance and testing regime to ensure accuracy.*

D.4 Please describe the operational and management structure that the project operator will implement in order to monitor emission reductions and any leakage effects, generated by the project activity

For the operation and maintenance of the project, O/M teams consisted of the engineers and the maintenance operators are formulated in the SPC. Monitoring procedures and QC/QA activities are conducted by the O/M teams stationing at the plant for 24 hours according to ISO 9001. Moreover displacement of gird electricity with landfill gas generated electricity monitored as electricity transmitted to the grid is controlled and assured by PLN as well as the SPC.

QC/QA activities are conducted by the organization shown in Figure 7 and their main activities are as follows.

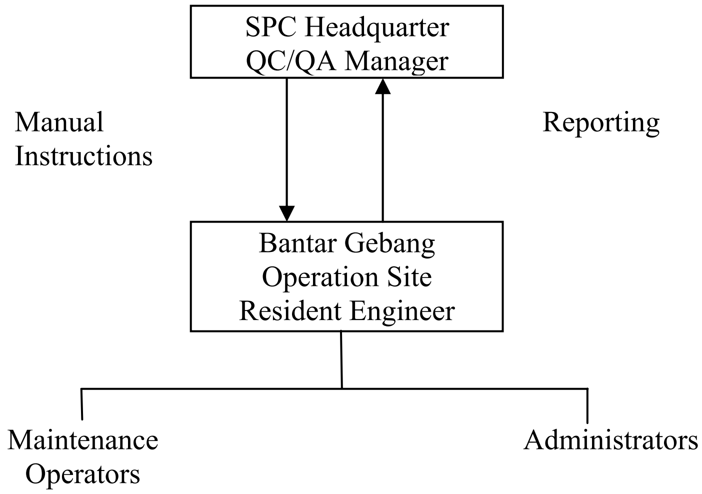

Figure-7 QC/QA and monitoring organization

►O/M Manual, Monitoring Manual, Emergency Manual

QC/QA manager makes the O/M manual and monitoring manual, emergency manual.

►Monitoring Records

Maintenance Operator(s) read and record monitored variables and input these data to computer database system. Administrator(s) inspects monitoring results everyday and makes a monitoring report to QC/QA Manager regularly.

►Maintenance Records

Maintenance Operator(s) maintains equipment and facilities according to the O/M manual. Maintenance Operator(s) patrols the site for the inspection of gas leakage on the site and facilities twice a day. Periodical maintenance of gas engine and pre-treatment facilities is conducted by each supplier. Maintenance Operator(s) records all maintenance work. Administrator(s) inspects maintenance results and makes a maintenance report to QC/QA manager regularly.

►Approval of maintenance order

Approval from the representative of SPC is necessary to request maintenance and/or repair work(s) by sub-contractor.

►Site audit of QC/QA manager

QC/QA manager makes regular site visits and inspects compliance of the site activities to the routine reminders.

►Emergency measure

Maintenance Operator(s) contacts QC/QA manager and a representative of SPC immediately in case of emergency, such as damages of the gas engine, gas pipe, etc. Emergency manual must be made to define incidents that should be reported to police station, fire station and city hall and hospital. All staff should act according to the emergency manual.

►Training of staff

The staff will be trained by the gas engine manufacturer according to the following schedule.

- Training during a test run of gas engine period.
- Development and improvement of skills on the job training with gas engine and other facilities maintenance team.

D.5 Name of person/entity determining the monitoring methodology:

Noboru Saeki
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Telephone: +81-3-3715-9958
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Minato-ku
Tokyo 107-8502
Japan
Telephone: +81-3-6229-6730
Fax: +81-3-5561-2153
E-mail: tanabeh@kajima.com

SECTION E. Estimation of GHG emissions by sources

E.1. Estimate of GHG emissions by sources:

Not applicable, because the project directly measures the methane gas captured, which will be the emission reduction by the proposed project. See the detailed monitoring plan in Chapter D.

The project boundaries in B.5 identify only one source of greenhouse gases, which is the landfill gas emitted from the landfill.

E.2. Estimated leakage:

No leakage effects need to be accounted under ACM0001 methodology.

E.3. The sum of E.1 and E.2 representing the project activity emissions:

Not applicable, because the project directly measures the methane captured, which will be the emission reduction by the proposed project. See the detailed monitoring plan in Chapter D.

E.4. Estimated anthropogenic emissions by sources of greenhouse gases of the baseline:

Not applicable, because the project directly measures the methane captured, which will be the emission reduction by the proposed project. See the detailed monitoring plan in Chapter D.

E.5. Difference between E.4 and E.3 representing the emission reductions of the project activity:

1. Actual emission reduction by projects estimated by monitoring

The monitoring plan provides for the calculation of ERs in the following way.

The CO_2 from methane combustion in electricity generators will be calculated on an annual basis as shown diagrammatically below:

STEP 1 – METHANE COMBUSTION IN ELECTRICITY GENERATORS

As and when electricity is generated, take the metered gross annual (aggregated from monthly readings) electricity produced by the proposed project
(MWh)

Multiplied by generator heat rate
(GJ/MWh)

Total energy input

(GJ)

Convert GJ to equivalent tones of methane
(using factors 0.0360 GJ/m^3CH_4 and 0.000714 tCH_4/m^3CH_4)
(tonnes of CH_4)

Multiply by Global Warming Potential of methane (21)
(tCO_2e)

Annual CO_2 emissions displaced by the proposed project through methane combustion to generate electricity
(<u>tonnes CO_2 equivalent</u>)

The CO_2 form methane combustion in flares will be calculated on an annual basis as shown diagrammatically below:

STEP 2 – Methane combustion in flares

Volume of landfill gas channeled to flares (m^3)

Multiplied by methane fraction of landfill gas (reading from the gas analyzer or deducted from the electricity generation readings)

Volume of methane combusted in flare (m^3)

Multiplied by flare efficiency

Net volume of methane combusted in flare (m^3)

Multiplied by volume mass conversion factor (0.000714 $tCH_4 = 1m^3\ CH_4$)
(tonnes of methane)

Multiplied by Global Warming potential of methane (21)
(tonnes of CO_2 equivalent)

⇩

Annual emission reductions due to methane combustion in flares
(tonnes of CO_2 equivalent)

STEP 3 – Total CERs generated by the project (tCO_2)

(Results of Step 1 + Step 2) minus EFA (0%)

⇩

Total CERs generated by the project (tCO_2)

The total emission reductions (in tones of CO_2 equivalent) are the summation of results from Step 1 (- Methane combustion in generators) and Step 2 (- Methane combustion in flares). The sum is, then, reduced by the EFA. As discussed in B.4, the project adopted the EAF of 0%.

2. Estimated emission reductions by the models

Only for the preliminary evaluation of the proposed project, we estimate emission reduction by the project as shown in A.4.4.1and Annex 3. Since the project adopted the EAF of 0%, CO_2 equivalent emission reductions are estimated by the following procedure (Refer to B.4).

$$(LFG_{project,y} - LFG_{reg,y}) * D\_CH_4 * GWP\_CH_4 + EG_y * CEF_{electricit\,y,\,y}$$
$$= LFG_{project,y} * D\_CH_4 * GWP\_CH_4 + EG_y * CEF_{electricity,\,y}$$

where D_CH_4 is methane density, and
GWP_CH_4 is the approved Global Warming Potential value for methane.

E.6. Table providing values obtained when applying formulae above:

Due to the nature of the ER monitoring and calculation process most appropriate for this project (i.e., direct monitoring of emission reductions), the above formulae, which are presented only for estimation purpose, is used to complete the Table-8 below. Please note that this Table is only an estimate of expected values.

Table-8 Summary of Baseline and Project Emissions (in tCO_2e)

Crediting Period	Emissions Baseline	Emissions Project	Emission Reductions
10 years	2,989,000	1,799,000	1,190,000

SECTION F. Environmental impacts

F.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

This project is consisted of LFG collection and small power generation utilizing it and therefore the project will contribute to improve the local environment by collection and combustion of the uncontrolled LFG at the site while there is limited environmental impact by generation.

In Indonesia environmental impact assessment is required in the case of construction of new landfill site having the extent area more than 10ha or construction of electricity generation facility having the capacity more than 10MW and this is not the case. This project does not aim to establish any new landfill site. In addition, the capacity of electricity generation is approximately 2MW.

In this project, preparation of Environmental Impact Assessment (EIA) is not required but detailed establishment plan (PAT) describing the project components and specifications of the facilities concerned has to be submitted to the Local Government. PAT is an examination procedure for environment influence of the project.

Major components of landfill gas are methane and carbon dioxide, which are colorless and odorless. Major global environmental concern over these compounds is the fact that they are greenhouse gases.

If landfill gas is generated in the confined area with high concentrations, there is a risk of asphyxiation and/or toxic effects on human body. But the risk of toxic effects on the local community and environment will be significantly reduced by collection and combustion of landfill gas. Although power generation from landfill gas may produce nitrogen oxides emission, it could be minimized by NO_X-controlling type generators.

Combustion of landfill gas may also result in the release of organic compounds and toxic substances including mercury and dioxins. Nevertheless these emissions are also regarded as much less harmful than continuous uncontrolled release of landfill gas.

The following aspects of operation of the landfill gas to energy project have also been addressed:

Noise: The main contributor this impact will be the gas engine generator and air compressor. Although the engines and air compressor will be placed to reduce noise emissions, there will be some increase in noise from the landfill site associated with energy recovery. If the resultant noise level at the fencing is greater than 65dB(A), the enclosure should be needed for gas engine and air compressor.

Gas Emission: The potential gas emission during operation phase is sulphur dioxide, nitrogen oxides, particle and others.

-Emission of sulphur dioxide will remain within Emission Standard of 800mg/m3(at 25℃,1atm) as stipulated in Decree of State Minister for Environment No.13 of 1995.
-Emission of nitrogen oxides will remain within Emission Standard of 1,000mg/m3(at 25℃,1atm) as stipulated in Decree of State Minister for Environment No.13 of 1995.
-Particulate production from the combustion of LFG is low as it is mainly in the form of soot. Principally it is known that particulate emission from gas firing is very negligible.
-Other pollutant is mainly carbon monoxides and small amount of hydrocarbon with a negligible quantity.

To enhance the maximum removal of sulphur dioxide and nitrogen oxides from the exhaust gas stream, scrubber and low-NO_x type gas engine will be installed.

Odor: During gas collection process, there will be some odor nuisance. Soil cover for landfill waste will eliminating this odor problem as well as enhancing LFG recovery.

Wastewater discharge: The wastewater discharge will be mainly from the cooling water. The scrubber is installed for decreasing the temperature of LFG. However, quantity of accessorily hydrogen sulphide and carbon dioxides dissolved in the cooling water is negligible.

Visual amenity: Soil covering for gas collection system will also put the landfill waste out of sight thus removing visual nuisance of the site.

Where landfill gas utilization schemes, such as this project, are developed in Indonesia, there is also an opportunity to promote best practices to improve landfill management standards, and contribute towards global sustainable development.

F.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

No significant negative impacts to the environment will result from the project activity. On the contrary the following environment benefits will result in:
►Significant reduction of methane emission.
►Generation of green energy.
►Reduction of toxic gas emission(like CH_4, H_2S, etc).
►Improvement of landfill cover, reducing leachate generation.
►Reducing risk of groundwater pollution by good quality cover soil.
►Reduction of nuisance odor.

SECTION G. Stakeholders' comments

G.1. Brief description how comments by local stakeholders have been invited and compiled:

Comments of local stakeholders were compiled through interview survey in three categories summarized below from October 2004 to January 2005.

Table-9 List of Stakeholders

Category	Stakeholders	Status	Survey Period
1.Governmental organizations	Central Government a. Ministry of Public works b. Ministry of Energy and Mineral Resources c. State Ministry of Environment Local Government d. DKI Jakarta Cleaning Department e. KOTA Bekasi Environmental Agency	Responsible ministry of SWM policy Responsible ministry of renewable energy policy Responsible ministry of Environment Landowner Responsible for landfill operation Location of landfill Responsible for landfill operation	1st November 2004 4th November 2004 28th October 2004 2nd November 2004 4th November 2004
2.Private entities	a. PLN Renewable Energy Society b. Patriot Bangkit Bekasi	National Electric Company Responsible for renewable energy Planning Local enterprises Landfill operating Company	5th November 2004 28th January 2005
3.Community	a. Resident Associations	Community Residents	Explanation Meeting (s) to the Resident Associations will be held in March.

In the interview survey the proposed project was discussed with the explanation materials in which the environmental and social impacts of the construction and operation of the project were described.

Documentations to support these activities are available in the form of record of interview and minutes of discussion.

In September 29th of 2004, Ministry of Public works constituted the counterpart team (including above Governmental Organizations) for implementation of this project. They expressed all-out support to this feasibility study.

G.2. Summary of the comments received:

Through the interview survey with the explanation materials of the project, comments were received as follows:

From governmental organizations:

Central government organizations of MOPW as responsible ministry of solid waste management policy, MOEMR as responsible ministry of renewable energy policy and MOE as responsible ministry of environmental conservation have welcomed the project from the point that the government is encouraging the development of renewable energy projects for diversifying the source of energy and that the project will environmentally contribute to the safety closure of urban solid waste landfill site.

MOPW stated that they do not have the policy to enforce the LFG collection and utilization of the existing or closing municipal solid waste landfill sites.

Local governments of Jakarta who dispose their municipal waste at Banter Gebang Landfill and Bekasi City Council who govern the landfill site as an administrative office of the area also accepted the project. In addition to the reasons mentioned above, they support this project because they expect the post closure utilization of the landfill site after the acceleration of landfill stabilization by extracting methane gas by the project.

Environment Department of Bekasi City confirmed that the preparation of DEIA, Detailed Environmental Impact Assessment won't be required for the proposed project. Instead, PAT, a simplified project registration, will be required.

From private entities:

PLN, National Electric Company, has agreed to receive the electricity generated by the project as a small renewable energy resource at a designated point in their distribution grid lines.

PBB, the operator of the existing Banter Gebang Landfill site, declared a strong interest for participation to this project.

From Community residents:

Explanation meeting will be held in March 2005.

G.3. Report on how due account was taken of any comments received:

There were favourable comments to the project except the unknown response from the residents of Banter Gebang site.

Annex 1

CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY

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Represented by:	HIROAKI TANABE
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Annex 2

INFORMATION REGARDING PUBLIC FUNDING

None

Annex 3

BASELINE INFORMATION
-Estimation of captured gas from landfill gas emission-

1. Gas generation potential

Gas generation potential G_e was calculated by using the following equation practiced in Europe. The parameters in the equation were determined by site measurements and laboratory tests of samples collected at the ZoneV (Bantar Gebang landfill site).

$G_e = 1.868 \times C_0 \times (0.014 \times d + 0.28)$---(a)

G_e: gas generation potential,

C_0: amount of total organic carbon in waste, and

d: temperature in landfill.

In estimating the landfill gas emission for the proposed project, C_0 is determined from the laboratory test on the solid waste sampled at ZoneV, and the temperature inside the observation well in the solid waste was measured for d.

G_e is approximately 146.45 m^3/t.

Where: $C_0 = 80.0$ kg/t, d = 50 degrees*,

* Temperature(used for calculation) was revised from 43 degree(average measured temperature was 43.5) to 50 degree, because temperature was not measured inside the solid waste but at the top of the well pipe and measured value was influenced of atmospheric temperature(35～40 degree).

2. An annual gas generation

An annual gas generation was calculated by using the following First Order Decay Model (the IPCC Guidelines for National Greenhouse Gas Inventories Volume 3: Reference Manual (1996), p. 6.11)

LFG volume emitted in the year j from the solid waste deposited in the year i (V_j).

$V_j = M_i \times G_e \times k \times e^{-k(j-i)}$ ---(b)

M_i: amount of solid waste deposited in the year i (ton)

k: decay rate (1/year)

3. Estimation of decrease of methane gas emission and captured gas in the project period

An annual emission of LFG volume was calculated from (b). Naturally, it reduced year after year. If efficiency of gas capturing system was assumed to be constant, the trend of reduction of gas emission should be quite similar to that of captured gas volume. Therefore we assume, that an annual captured gas volume was estimated by using the trend of reduction of gas emission.

(1) Trend of reduction of gas emission volume during the project period

Annual gas emission volumes were shown in Table-1. The relation between gas emission and elapsed time was calculated from annual gas emission volume.

(2) Trend in change of captured gas volume during the project period

Taking the trend of reduction of gas emission volume during the project period into account, annual volume of CH_4 captured was also shown in Table-1.

Table-1: Annual gas emission and captured gas volume

Year	Annual LFG volume (m^3/year)	Annual CH_4 volume (m^3/year)	Annual CH_4 captured** (m^3/year)
2008	71,454,000	35,727,000	10,236,000
2009	61,501,000	35,751,000	9,724,000
2010	52,935,000	26,467,000	9,212,000
2011	45,561,000	22,781,000	8,701,000
2012	39,215,000	19,607,000	8,189,000
2013	33,753,000	16,876,000	7,677,000
2014	29,051,000	14,526,000	7,165,000
2015	25,005,000	12,502,000	6,653,000
2016	21,522,000	10,761,000	6,142,000
2017	18,524,000	9,262,000	5,630,000

**Annual CH_4 captured was estimated from annual gas flow velocity.

4. Estimation of CO2 equivalent emission reduction by project

CO_2 reduction by project is calculated as a sum of emission reduction by methane actually destroyed/combusted and emission reduction by displacing the grid electricity during the project period.

Table 2 shows annual CO_2 reductions by the proposed project.

Table 2: CO_2 reduction regarding landfill gas collection

Year	CO_2 Emission by Baseline (ton/year)	CO_2 Emission by Project (ton/year)	CO_2 Reduction by Project (ton/year)
2008	536,000	382,000	154,000
2009	461,000	315,000	146,000
2010	397,000	259,000	138,000
2011	342,000	211,000	131,000
2012	294,000	171,000	123,000
2013	253,000	138,000	115,000
2014	218,000	110,000	107,000
2015	188,000	88,000	100,000
2016	161,000	69,000	92,000
2017	139,000	54,000	84,000

Referenc

A. SUMMARY OF PARAMETERS AND CONDITIONS

Costs

1	Initial Cost	US$	6,000,000.00	
2	Loan Amount	US$	0.00	
	Percentage of Loan		0%	
	Returning Period		10	year
	Total Loan Payment each Year	US$	0.00	
3	Operational & Maintenance Cost	US$	240,000.00	
4	Inflation Rate *1		5.78%	
5	Corporate Tax *2		30%	
6	Salvage Value		0.00	
7	Annual Depreciation Rate		12.5%	
8	Electricity for Operation		5%	
9	CDM Administration Fee		5%	
10	Conversion Rate of $ to $		1.00	

Methane Gas

1	Total Organic Carbon in Waste (TOC)	80.00	kg/t
2	Decay Rate (k value)	0.15	/yr
3	Methane Concentration in Landfill Gas (CH4)	50%	
4	Methane Gas Potential (Ge)	146.45	m3/t
	Borehole Diameter	0.07	m
	Number of Boreholes	120	
	Per unit wait of waste	0.323	t/m3
	Temparature	50	℃

Electricity Computation

1	CO2 Emission Volume		0.48	/kg
2	Electicity Price	US$	0.04	/kwh
3	Annual Power Generation Availability		90%	

Pareameters for Electricity Generation

1	Caloric Value of Methane	8,600.00	kcal/m3
2	Conversion from Calorie to Joule	4.1861	J/cal
3	Power Generation Efficiency	25%	

Notes:

1 Depreciation is exempted from tax
2 Property tax is not considered
3 Income comes only from Sale of Electricity

*1 Data Source: Central Bureau of Statistics, "Statistical Year Book of Indonesia,2 2003
*2 Data Source: JETRO Indonesia

Corporate Tax Rates

-10% for taxable income up to Rp. 50 million.
-15% for taxable income between Rp. 50 and 100 million.
-30% for taxable income in excess of Rp. 100 million.

B. CO_2 Emission Reduction by Baseline and by Project

	LFG Emission Vol. (m^3/day)	CH_4 Emission (m^3/day)	CH_4 Capture (m^3/day)	CO_2 Reduction (ton/yr)	CO_2 Emission by Baseline (ton/yr)	CO_2 Emission by Project (ton/yr)
2008	195,765	97,883	28,044	153,538	535,907	382,369
2009	168,497	84,248	26,641	145,861	461,260	315,398
2010	145,026	72,513	25,239	138,184	397,010	258,825
2011	124,825	62,413	23,837	130,508	341,710	211,202

C. ELECTRICITY SALE BY POWER GENERATION

CO_2 emission vol./kg	=	0.48			
Electicity Price (US$/kwh)	=	0.04			
% of electricity to produce	=	90%			
electricity for operation	=	5%			
Year	mwh/day	Electricity Generated kwh/year	CO_2 in ton	Total	Income from Electricity Sales
2008	70.1	23,030,762	10,590	85,511	875,169
2009	66.6	21,879,224	10,060	81,235	831,411
2010	63.1	20,727,686	9,531	76,960	787,652
2011	59.6	19,576,148	9,001	72,684	743,894
2012	56.1	18,424,610	8,472	68,408	700,135
2013	52.6	17,273,072	7,942	64,133	656,377
2014	49.1	16,121,534	7,413	59,857	612,618
2015	45.6	14,969,996	6,883	55,582	568,860
2016	42.1	13,818,457	6,354	51,306	525,101
2017	38.6	12,666,919	5,824	47,031	481,343

D. CALCULATION OF INTERNAL RATE OF RETURN									
initial value (project value)	=	6,000,000.00	US$						
loan amount	=	0.00							
returning period (year)	=	10							
operational period (year)	=	10							
salvage value	=	0.00							
inflation rate	=	**5.78%**							
corporate tax	=	**30.00%**							
discount rate	=	**9.50%**	**2,443,082.46**						
subsidy	=	**0.00%**							
operation cost present	**capital cost**	**operation cost future**	**depreciation present**	**depreciation future**	**benefit present**	**benefit future**	**taxable amount**	**tax future**	**net profit future**
	6,000,000.00								**-6,000,000.00**
240,000.00		**253,872.00**	**750,000.00**	**793,350.00**	**0.00**	**875,168.97**	**-172,053.03**	**0.00**	**621,296.97**
240,000.00		**268,545.80**	**750,000.00**	**839,205.63**	**0.00**	**831,410.52**	**-276,340.91**	**0.00**	**562,864.72**
240,000.00		**284,067.75**	**750,000.00**	**887,711.72**	**0.00**	**787,652.08**	**-384,127.39**	**0.00**	**503,584.33**
240,000.00		**300,486.86**	**750,000.00**	**939,021.45**	**0.00**	**743,893.63**	**-495,614.69**	**0.00**	**443,406.76**
240,000.00		**317,855.01**	**750,000.00**	**993,296.89**	**0.00**	**700,135.18**	**-611,016.72**	**0.00**	**382,280.17**
240,000.00		**336,227.02**	**750,000.00**	**1,050,709.45**	**0.00**	**656,376.73**	**-730,559.75**	**0.00**	**320,149.70**
240,000.00		**355,660.95**	**750,000.00**	**1,111,440.46**	**0.00**	**612,618.28**	**-854,483.13**	**0.00**	**256,957.33**
240,000.00		**376,218.15**	**750,000.00**	**1,175,681.72**	**0.00**	**568,859.83**	**-983,040.04**	**0.00**	**192,641.68**
240,000.00		**397,963.56**	**0.00**	**0.00**	**0.00**	**525,101.38**	**127,137.83**	**38,141.35**	**88,996.48**
240,000.00		**420,965.85**	**0.00**	**0.00**	**0.00**	**481,342.94**	**60,377.08**	**18,113.12**	**42,263.96**
2,400,000.00	**6,000,000.00**		**6,000,000.00**	**7,790,417.32**		**6,782,559.54**		**56,254.47**	**3,414,442.12**
								Project IRR=	**-12%**

Annex 4

MONITORING PLAN

1. Introduction

This plan contains a proposed monitoring system to determine the reduction of the greenhouse gas emission. In the case of the proposed project, the greenhouse gas will be reduced by collecting, flaring and using LFG (landfillgas) as fuel for electricity generation with installation of gas extraction wells, collection pipe system, flare combustor and power plant facilities. These LFG collection and electricity generation facilities will be provided with a monitoring system to quantify the reduction of greenhouse gas emission. The verification for the reduction of the greenhouse gas emission will be conducted according to this monitoring plan. Quality control and quality assurance activities for the monitoring systems are also described as well as the description of the monitoring system.

2. Process

Banter Gebang Landfill is generating LFG, containing approximately 50% methane gas (CH_4) which is a greenhouse gas and has the greenhouse effect of 21 times more than CO_2.

As shown in Figure-1, the LFG will be extracted from gas wells constructed at the landfill site and delivered to the power plant for electricity generation through gas collection pipe system while the surplus or total gas during stoppage of the generation units will be treated in the flare combustor.

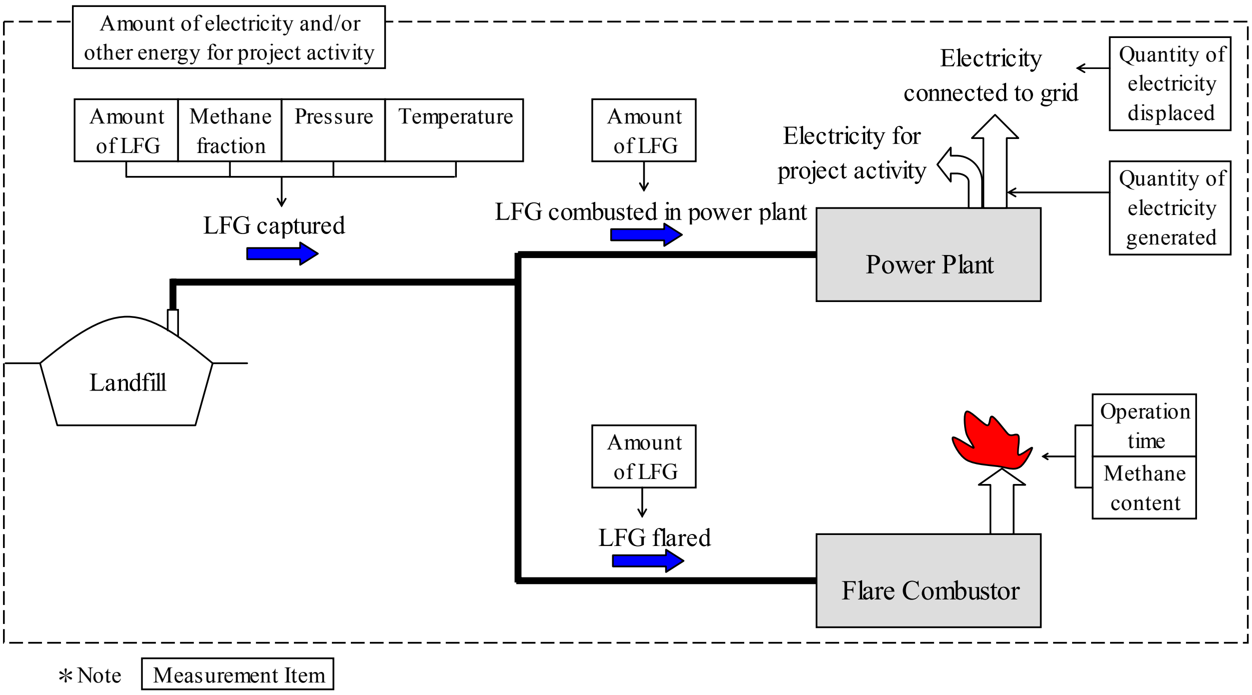

Figure-1 Schematic of monitoring

3. Calculating reduction of greenhouse gas emission

In the project activity, there are three components for the reduction of greenhouse gas emission;

- Methane collection and flare
- Methane collection and electricity generation
- Displacement of grid electricity with the electricity generation by landfill gas

The formulae used to calculate project emission reduction is:

$Er_y = (Md_{project,y} – Md_{reg,y}) \times GWP\_CH_4 + EG_y \times CEF_{electricity,y}$

Where:

y : Duration of the project activity, 10 years
Er_y : Greenhouse gas emission reduction measured in tonnes of CO_2 equivalents (tCO_2e)
$Md_{project,y}$: Amount of methane actually combusted measured in tonnes of methane (tCH_4)
$Md_{reg,y}$: Amount of methane that would have been combusted during the absence of the project activity measured in tonnes of methane (tCH_4) and currently $Md_{reg,y}$= zero
GWP_CH_4 : Approved Global Warming Potential value for methane (GWP_{CH4}) for the first commitment period is 21 tCO2e/tCH_4
EG_y : Quantity of electricity displaced measured in mega watt hour (MWh)
$CEF_{electricity,y}$: CO_2 intensity of the electricity displaced expressed in tonnes of CO_2 equivalents per mega watt hour (tCO_2e/MWh)

$Md_{projecy,y}$ is sum total $Md_{electricity}$ and $Md_{flare,y}$ as follows.

$Md_{project,y} = Md_{electricity,y} + Md_{flare,y}$

and each formulae used to calculate $Md_{electricity,y}$ and $Md_{flare,y}$ is as follows.

$Md_{electricity,y} = LFG_{electricity,y} \times w_{CH4,y} \times D_{CH4}$

Where:

$LFG_{electricity,y}$: Quantity of landfill gas combusted in power plant measured in cubic meters (m^3)
$w_{CH4},_y$: Methane fraction of the landfill gas measured in cubic meters of methane per cubic meters of landfill gas (m^3CH_4/m^3LFG)
D_{CH4} : Methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3 CH_4) and determined by temperature and pressure of LFG

$Md_{flare,y} = LFG_{flare,y} \times \times w_{CH4,y} \times D_{CH4} \times FE$

Where:

$LFG_{flare,y}$: Quantity of landfill gas flared measured in cubic meters (m^3)
$w_{CH4},_y$: Methane fraction of the landfill gas measured in cubic meters of methane per cubic meters of landfill gas (m^3CH_4/m^3LFG)
D_{CH4} : Methane density expressed in tonnes of methane per cubic meter of methane (tCH_4/m^3 CH_4) and determined by temperature and pressure of LFG
FE : Flare efficiency is expressed in percentage (%) and determined by the operation hours of flare combustion and the methane content in flare exhaust gas

4. Monitoring and logging system

In order to determine the data of the above parameters following data will be measured , monitored and/or collected and recorded electronically. The table below shows all the parameters.

Table-1 Monitoring Items and Measuring Devices

ID number	Data variable	Source of data	unit	Measuring device
1	LFGtotal,y	Total amount of landfill gas captured	M^3	Flow meter
2	LFGflare,y	Amount of landfill gas flared	M^3	Flow meter
3	LFGelectricity,y	Amount of landfill gas combusted in power plant	M^3	Flow meter
4	FE	Flare/combustion efficiency, determined by (1) the operation hours and (2) the methane content in the exhaust gas	%	Thermometer and Sampling/ Laboratory analysis
5	w_CH4,y	Methane fraction in the landfill gas	m^3CH_4/ m^3LFG	Analyzer
6	T	Temperature of the landfill gas		Thermometer
7	P	Pressure of the landfill gas	Pa	Manometer
8	Etotal,y	Total amount of electricity and/or energy carriers used in the project for gas pumping	MWh	Power meter
9	CEFenergy,y	CO2 emission intensity of the electricity and/or other energy carriers in ID8	tCO_2/ MWh	Given data
10	EGtotal,y	Quantity of electricity generated	MWh	Power meter
11	EGy	Quantity of electricity displaced	MWh	Power meter

Every hour all process parameters will be measured and/or analyzed and recorded in the data-logger of the facilities. Once a day, the data will be transferred to the PC for the storage. The PC monitoring station is containing;

- visualization system of the process for operating purposes;
- database to store the received process data and
- system to provide alarm signals to the operators.

5. Quality assurance and quality control of the measurements and monitoring

The following parameters are important because the verification of greenhouse gas emission reduction will be done dbased on these parameters.

- LFG amount [Nm^3],
- electrical power generation and consumption [MW.h]
- methane content [Vol.%] and

Quality assurance and quality control of these three monitoring parameters will be conducted as follows;

5.1 LFG quantity

Flow meter

The LFG quantity will be measured by means of a flow meter. The flow meter is a counter which counts every passed amount by m^3LFG. Further the influence of pressure and temperature on the gas amount will be corrected by means of thermometer and manometer. The measurements of counted gas amount quantity will be provided to the data-logger and monitoring PC of the facilities.

Logging

As described the LFG amount will be logged (once per hour) and transferred (once per day) to the database of the monitoring system.

Calibration

According the specifications of the flow meter, every 4 years the flow meter has to be calibrated. The flow meter will be send to the supplier for calibration. Meanwhile, during calibration, the flow will be measured by means of a alternative flow meter (same type). The results of the 2 flow meters and the beginning and ending gas amount will be stored separately in the database.

5.2 Electrical power generation and consumption

kW.h meter

The electrical power generation and consumption will be measured by means of a kW.h-meter. The kW.h meter is a counter and counts every consumed kW.h.

This quantity is true and cannot be manipulated because the kW.h meter is sealed by PLN. The kW.h

Logging

The logging procedure of the electrical power generation and consumption is the same as the logging procedure of the LFG amount. Once an hour the electrical power consumption will be measured and stored in the data logger of the facilities and transferred once a day to the monitoring PC.

Power meter for the electricity displaced (= electricity transferred to the PLN grid) will be maintained and calibrated by PLN.

5.3 Methane content

Methane analyzer

The methane content of the LFG will be measured by means of the methane analyzer.

Logging

Once an hour the methane content will be sampled and stored in the data logger of the facilities. Once a day these data will be transferred to the monitoring system.

Calibiration

According the specifications of the flow meter, every 4 years the analyzer has to be calibrated. The method of calibration will be standard sample method.